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New records and modeling potential distribution of *Plestiodon tamdaoensis* (Bourret, 1937) and *Scincella devorator* (Darevsky, Orlov & Ho, 2004) in Vietnam (Scincidae)

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Abstract

The Vietnam Skink (*Plestiodon tamdaoensis*) was described from Tam Dao National Park, Vietnam, in 1937, and the species is currently known only from northern Vietnam and Hong Kong of China, whereas the Devouring Forest Skink (*Scincella devorator*) was described from Yen Tu Nature Reserve, Vietnam, in 2004, and the species is endemic to northern Vietnam. As a result of our field surveys in 2023 and 2024 in Ba Vi National Park, Vietnam, we reported new distribution records, morphological data, and natural history of *Plestiodon tamdaoensis* and *Scincella devorator*. In addition, we used species distribution modeling to predict the potential distribution of these species. The model showed that the potential distribution of *P. tamdaoensis* is approximately 110,000 km^2 and that of *S. devorator* is approximately 130,000 km^2, covering northern Vietnam, southern China, and northern Laos, significantly expanding its known range compared to the IUCN range map.

Key Words

Ba Vi National Park, Ha Noi City, morphology, Scincidae, species distribution modelling

Introduction

The family Scincidae currently contains 1971 recognized species with a broad distribution worldwide (Uetz et al. 2024). Nguyen et al. (2009) recorded 46 species of Scincidae from Vietnam. Since then, a total of 69 species of the family have been documented from the country (Uetz et al. 2024), including new records and newly discovered species. Eleven new species of skinks have been described from Vietnam over the last 10 years, viz. *Lipinia trivittata* Poyarkov, Geissler, Gorin, Dunayev, Hartmann & Suwannapoom; *L. vassilievi* Poyarkov, Geissler, Gorin, Dunayev, Hartmann & Suwannapoom; *Lygosoma siamense* Siler, Heitz, Davis, Freitas, Aowphol, Termprayoon & Grismer; *Scincella badenensis* Nguyen, Nguyen, Nguyen & Murphy; *S. baraensis* Nguyen, Nguyen, Nguyen & Murphy;

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S. ouboteri Pham, Pham, Le, Ngo, Ziegler & Nguyen; *S. fansipanensis* Okabe, Motokawa, Koizumi, Nguyen, Nguyen & Bui; *Sphenomorphus phuquocensis* Grismer, Nazarov, Bobrov & Poyarkov; *S. preylangensis* Grismer, Wood, Quah, Anuar, Poyarkov, Thy, Orlov, Thammachoti & Seiha; *S. yersini* Nguyen, Nguyen, Nguyen, Orlov & Murphy; *Subdoluseps vietnamensis* Le, Nguyen, Phan, Rujirawan, Aowphol, Vo, Murphy & Nguyen (Nguyen et al. 2018, 2020; Siler et al. 2018; Poyarkov et al. 2019; Grismer et al. 2020; Okabe et al. 2024, Pham et al. 2024).

Plestiodon tamdaoensis (Bourret, 1937) and *Scincella devorator* (Darevsky, Orlov & Ho, 2004) are two poorly known species of skinks in Vietnam. *Plestiodon tamdaoensis* is listed as Least Concern, while *Scincella devorator* is listed as Data Deficient in the IUCN Red List, and both species are known only from very few records in northern Vietnam and southern China (IUCN 2024).

The Vietnam Skink (*Plestiodon tamdaoensis*) was described from Tam Dao National Park, Vietnam, by Bourret (1937). *P. tamdaoensis* was subsequently recorded in evergreen forests of Ha Giang, Cao Bang, Bac Kan, Vinh Phuc, Bac Giang, Hai Duong, Son La, Hoa Binh, Thanh Hoa, and Nghe An provinces in Vietnam and Hong Kong in China at elevations from 300 to 1200 m a.s.l. (Nguyen et al. 2009; Hoang et al. 2020; Uetz et al. 2024; Dau et al. 2024). The Devouring Forest Skink (*Scincella devorator*) was described from Quang Ninh Province, Vietnam, by Darevsky et al. (2004) as a member of the genus *Sphenomorphus*. Nguyen (2011) reported this species from Yen Tu Mountain in Bac Giang Province and transferred the species to *Scincella* on the basis of the following diagnostic characteristics: lower eyelid with an opaque window and lower secondary temporal overlapped upper scale. Ziegler et al. (2015) recorded the species in Vinh Phuc Province. Pham et al. (2015) found another population of *S. devorator* in Son La Province. This species inhabits evergreen forests at elevations from 300 to 1590 m a.s.l. (Darevsky et al. 2004; Pham et al. 2015, 2018; Ziegler et al. 2015).

In this study, we report the occurrences of *Plestiodon tamdaoensis* and *Scincella devorator* in Ba Vi National Park (NP), which belongs to Hanoi City, for the first time based on newly collected skink specimens. Moreover, we predict potential distribution of those skink species in northern Vietnam and southern China based on species distribution modeling.

Materials and methods

Field surveys

Field surveys were conducted in Ba Vi NP in July 2023 and in August 2024 by A.V. Pham, H.T.T. Nguyen, and C.H. Tran. Ba Vi NP is located in Ba Vi District of Hanoi City and Luong Son and Ky Son districts of Hoa Binh Province, with a total area of 10,814.6 ha (Luu et al. 2020). The natural habitat of Ba Vi NP is characterized by evergreen mixed forest of coniferous and broadleaf at elevations above 600 m a.s.l. (Vem 2016). In terms of climatic conditions, the national park is located in the subtropical climate region of northern Vietnam, with an annual average rainfall of 900 mm, an annual average temperature of 21.8 °C), and an annual average humidity of 79% (Nguyen 2000).

Two survey transects were set up in natural forest at elevations between 700 and 1960 m asl. Transect 1 along the forest trail to the Vua Peak (starting point: 21°03'41.3"N, 105°21'44.2"E, elevation: 960 m; end point: 21°03'29.3"N, 105°21'58.0"E, elevation: 1160 m); Transect 2 along the forest trail to the Old Church (starting point: 21°04'31.2"N, 105°21'50.1"E, elevation: 790 m; end point: 21°04'22.2"N, 105°21'57.1"E, elevation: 860 m). Skinks were collected by hand between 8:30 and 16:00 hrs following the guideline approved by the American Society of Ichthyologists and Herpetologists for animal care (Beaupre et al. 2004). After having been photographed in life, animals were anesthetized and euthanized in a closed vessel with a piece of cotton wool containing ethyl acetate (Simmons 2002), fixed in 85% ethanol and subsequently stored in 70% ethanol. Specimens were subsequently deposited in the collection of the VNU University of Science (HUS), Vietnam.

Morphological analysis

Measurements were taken with a caliper to the nearest 0.1 mm; abbreviations are as follows: SVL: Snout-vent length, TaL: Tail length. Scalation: Paravertebral scales (number of scales in a line from the posterior edge of parietals to the dorsal point opposite the posterior margin of the medial precloacals); ventral scale rows (number of scales from the first gular to the anterior margin of precloacals) (Pham et al. 2024). Bilateral scale counts are given as left/right.

Species distribution modeling

In addition to the records from our field surveys, other localities of the *Plestiodon tamdaoensis* and *Scincella devorator* from published papers, field reports, and proceedings were also collated. The occurrence datasets were then checked and cleaned following the protocol suggested by Chapman (2005). To limit spatial autocorrelation issues, we used the spThin package (Aiello-Lammens et al. 2015) in R (R Core Team 2023) to thin out localities within five kilometers distance (Pearson et al. 2007). This created the final set of six records for *S. devorator* and 11 records for *P. tamdaoensis* as the input data for the MaxEnt model. We used 19 bioclimatic variables at 30-arcsec resolution available at the WorldClim 2.1 database (Fick and Hijmans 2017) and restricted the extent using a two-degree buffer around the minimum convex polygon of the occurrence localities (Anderson and Raza 2010).

We ran all analyses in MaxEnt version 3.4.4 (Phillips et al. 2017). We used feature class combinations and tested a range of regularization multiplier values from 0.5 to 10.0 with increments of 0.5. We used 10,000 background points for the modeling process, and all other parameters followed standard protocols (Phillips et al. 2017). We then used the jackknife method, which has been suggested for species with a low number of occurrence records, to construct distribution models (Pearson et al. 2007). To assess model performance and select the optimal one, we used the 10% omission rate threshold to select models that showed the least overfitting. From this set, we then chose the models with the highest Area Under the Curve (AUC) values. The last set of models was then selected based on the Akaike information criterion, which balances complexity with model fitness (Warren and Seifert 2011). For the final model, we used the 10% training presence threshold to classify between suitable and unsuitable areas for two skink species.

Results

Plestiodon tamdaoensis (Bourret, 1937)

Vietnam Skink / Thằn lằn tốt mã tam đảo

Specimen examined. • One subadult, collected on 28 August 2024 on the forest trail near Old Church (21°04'23.6"N, 105°21'56.9"E, at an elevation of 810 m), Ba Vi NP, Vietnam.

Description. Morphological characters of the specimen from Ba Vi NP agreed well with the descriptions of Bourret (1937), Hikida et al. (2001), and Hech et al. (2013): SVL 30.5 mm; TaL 46.5 mm (n = 1). Supranasals large, in contact with each other; frontoparietals in contact with each other; interparietal larger than frontoparietals; parietals separated; two pairs of nuchal scales; four supraoculars; postnasal single; three loreals; lower eyelid scaly; eight supraciliaries; eight supralabials; seven infralabials; tympanum deeply sunk, with three small lobules on the anterior edge; midbody scales in 24 rows, smooth; paravertebral scales 45; 52 transverse rows of ventrals, smooth; precloacals two, enlarged; fingers and toes meeting when adpressed; subdigital lamellae under fourth finger 13 and 19 under fourth toe.

In life, dorsal surface of head and body black with two cream stripes on body; lateral band black-brown with one cream stripe on each; all stripes extend from head to base of tail; dorsal surface of tail bright green; ventral surface light brown (Fig. 1). In preservative, dorsal surface of head, body, and tail brown with two cream stripes on body; lateral band black-brown; ventral surface light brown.

Ecological notes. The specimen was found at 10:00 on the ground at elevations of 810 m a.s.l. The surrounding habitat was a disturbed evergreen forest of medium hardwood, bamboo forest, and shrub. The humidity was approximately 75–85%, and the air temperature ranged from 26 to 32 °C.

Potential distribution. MaxEnt models showed great prediction power for the distribution of the skinks, with average AUC values > 0.91 for *P. tamdaoensis*. The optimal model had the regularization multiplier value of 2.5 and a combination of linear and quadratic feature classes and an AUC value of 0.9142. However, the regularization multiplier value of 2.5 for the optimal model means that the final model was slightly generalized. The final prediction should therefore be carefully interpreted as potential zones, and it may include regions that are not likely to have any *P. tamdaoensis* populations, especially in the edge areas. The model also encompassed all known records of the skink, including new localities (Fig. 2). The model also showed that the potential distribution of *P. tamdaoensis* can be as large as 110,000 km^2, significantly expanding its known range compared to the IUCN range map.

Figure 1. *Plestiodon tamdaoensis* (juveline, HUS 2024.15) from Ba Vi National Park, Vietnam.

Scincella devorator (Darevsky, Orlov & Ho, 2004)

Yen Tu Ground Skink / Thằn lằn cổ yên tử

Specimen examined. • One adult female, collected on 28 July 2023 on the forest trail near Vua Peak (21°03'38.1"N, 105°21'48.7"E, at an elevation of 1105 m), Ba Vi NP, Vietnam.

Description. Morphological characteristics of the specimens from Ba Vi NP agreed with the descriptions of Darevsky et al. (2004) and Pham et al. (2015): SVL 56.5 mm, TaL 76.1 mm (n = 1, female). Head longer than wide; rostral wider than high; supranasals absent; prefrontals separated from each other by frontal; parietals in contact posteriorly; three pairs nuchal scales, enlarged; two loreals; eight supraciliaries; four supraoculars; one primary temporal; two secondary temporals; a large, undivided, opaque window in lower eyelid; seven supralabials, the fifth and sixth below the eye; ear opening without projecting lobules; tympanum deeply sunk; mental wider than long; six infralabials; postmental undivided; 28 rows of midbody scales; scales of two vertebral rows on the neck widened; paravertebral scales 69; 65 transverse rows of ventrals, smooth; precloacals two, enlarged; medial subcaudals widened; limbs short, pentadactyl; fingers and toes meeting when adpressed; subdigital lamellae under fourth finger 14 and 17 under fourth toe.In life, dorsum and tail base lightly brownish gray, with a black, wide vertebral stripe and two lightly gray, clear bands extending from parietals to base of tail; a distinct black stripe from behind the eye to hind limb in upper lateral zone with; venter and under surface of tail base lightly cream (Fig. 3). In preservative, dorsum and tail base brownish gray, with a dark, wide vertebral stripe and two silver-gray clear bands extending from parietals to base of tail; a distinct dark stripe from behind the eye to hind limb in upper lateral zone; venter and under surface of tail base cream.

Ecological notes. The specimen was found at 10:15 am under a carpet of fallen leaves at an elevation of 960 m a.s.l. The surrounding habitat was a disturbed evergreen forest of medium hardwood and shrub. The humidity was approximately 70–80%, and the air temperature ranged from 26 to 30 °C.

Potential distribution. MaxEnt models showed reasonable prediction power for the distribution of the skinks, with average AUC values > 0.87 for *S. devorator*. The optimal model had the regularization multiplier value of 2.0 and a combination of linear and quadratic feature classes and an AUC value of 0.8967. However, as the number of localities used in the modeling process of this species was quite small, the model result should be interpreted with great caution, especially in the edge areas. The model also encompassed all known records of the skink, including new localities (Fig. 4). The model also showed that the potential distribution of *S. devorator* can be as large as 130,000 km^2, significantly expanding its known range compared to the IUCN range map.

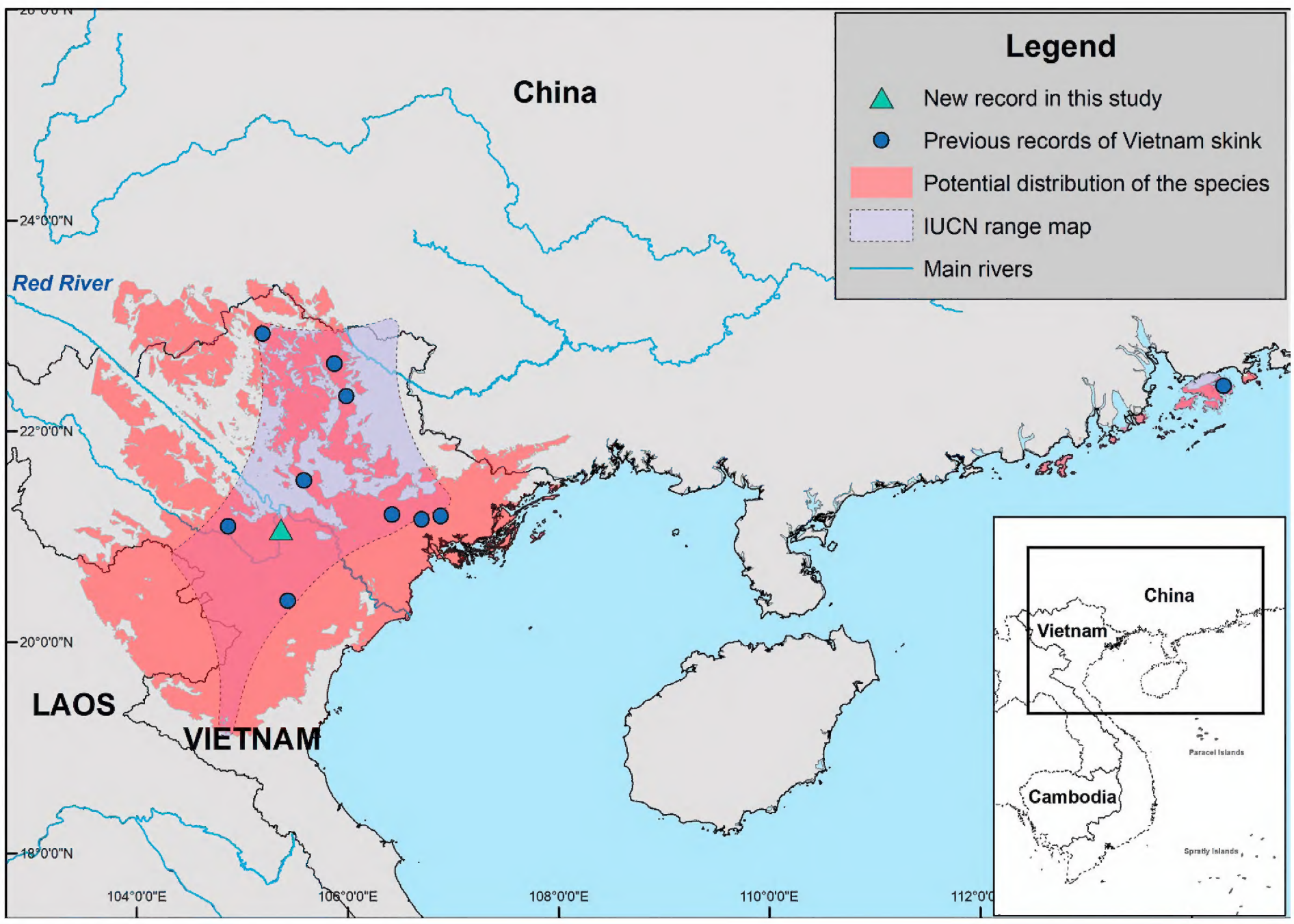

Figure 2. Potential distribution of *Plestiodon tamdaoensis*.

Figure 3. *Scincella devorator* (adult male, HUS 2024.16) from Ba Vi National Park, Vietnam.

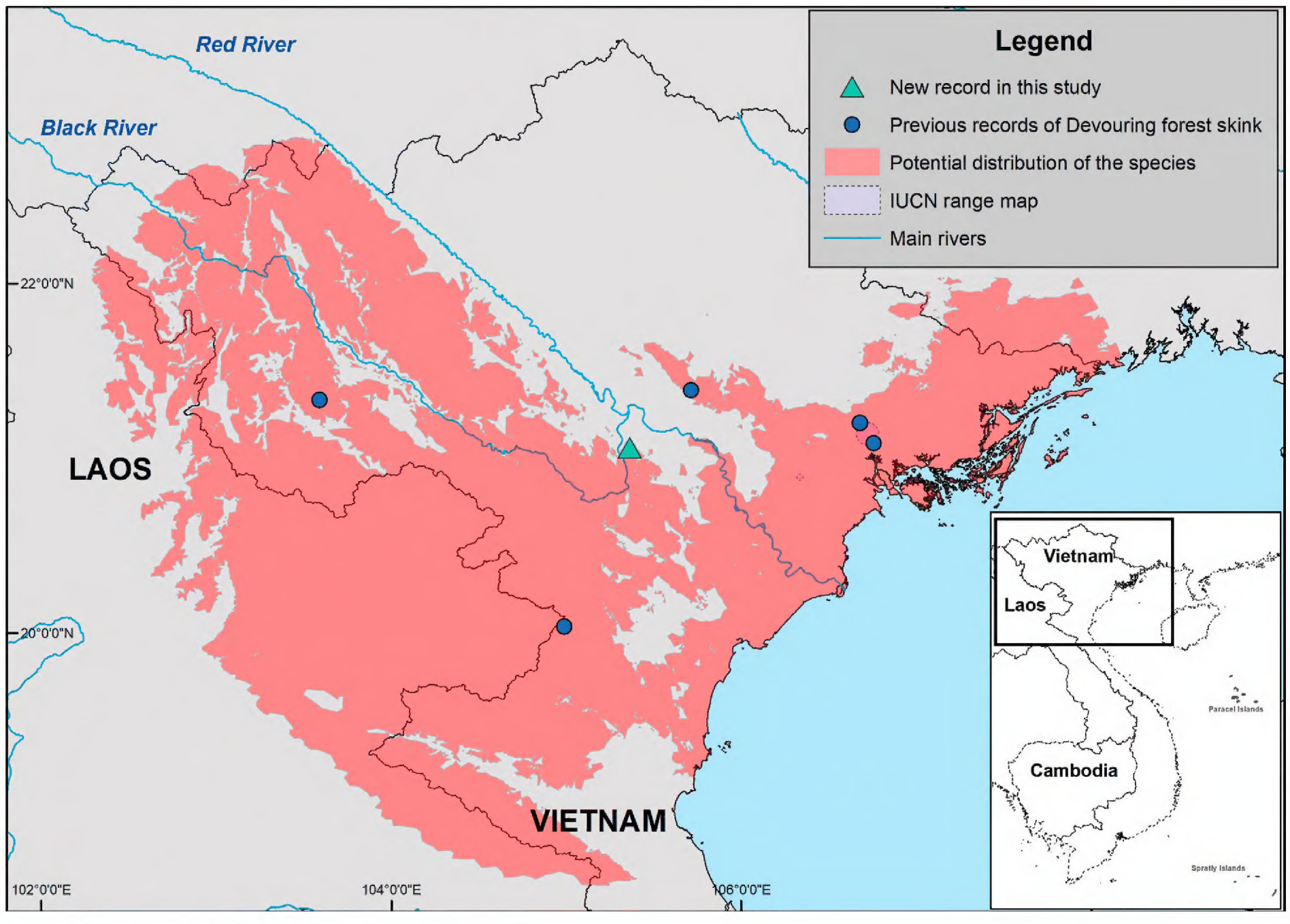

Figure 4. Potential distribution of *Scincella devorator*.

Discussion

Our new findings of two skink species from Ba Vi National Park bring the total number of reptile species in this national park to 52 (after Luu et al. 2020). In Vietnam, *P. tamdaoensis* has been recorded from Ha Giang, Cao Bang, Bac Kan, Vinh Phuc, Bac Giang, Hai Duong, Son La, Hoa Binh, and Nghe An provinces; elsewhere, the species is known from China (Nguyen et al. 2009; Uetz et al. 2024). *S. devorator* has been only recorded from Vietnam, including Quang Ninh, Bac Giang, Vinh Phuc, and Son La provinces (Darevsky et al. 2004; Pham et al. 2015; Ziegler et al. 2015).

In this study, we combined occurrence records from the literature on *P. tamdaoensis* (Bourret 1937; Hikida and Darevsky 1987; Hikida et al. 2001; Nguyen et al. 2009; Hech et al. 2013; Hoang et al. 2020) and *S. devorator* (Darevsky et al. 2004; Nguyen 2008; Pham et al. 2015; Ziegler et al. 2015; Dau et al. 2024) and our new records as input data for SDM analysis. However, the regularization multiplier values of 2.0 and 2.5 for the optimal models of two species mean that the final models were slightly generalized. The final prediction should therefore be carefully interpreted as potential zones, and it may include regions that are not likely to harbor any populations. Furthermore, as the number of localities used in the modeling process of these two species was quite small, the model results should be interpreted with great caution, especially at the edge areas.

The model results suggested that *P. tamdaoensis* is distributed in northern Vietnam and a small area in southern China. Similarly, *S. devorator* is distributed in northern Vietnam and a small area in southern China and northern Laos. Therefore, protected areas in these regions, especially those covered by a relatively large forest, probably form important habitats of *P. tamdaoensis* and *S. devorator*. Future research is needed to uncover additional records of these species, particularly in the Cuc Phuong–Ngoc Son Ngo Luong–Pu Luong–Pu Hu (Thanh Hoa, Ninh Binh, and Hoa Binh) and Dong Son Ky Thuong (Quang Ninh) regions.

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